IAEA Workshop on AI for Accelerating Fusion and Plasma Science
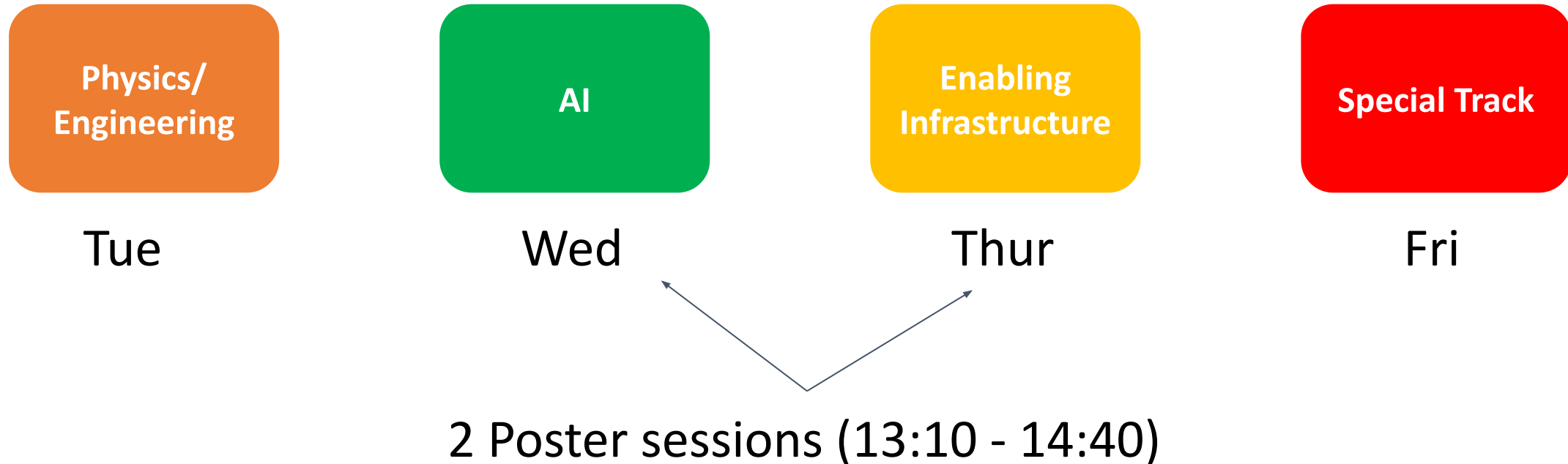
November 28, 2023 to December 1, 2023
IAEA Headquarters

Workshop Logistics

Physics/Engineering	AI	Enabling Infrastructure	Special Track
Tue	Wed	Thur	Fri

2 Poster sessions (13:10 - 14:40)

- Each day "intro to session" talk → present the summary slides from invited speakers of the day.
- Discussion sessions:
  - Expand on the presented topics, highlight open questions, reconnect to **CRP** use cases where possible
  - Bring up critical issues for data-centric community, e.g. data generation / access / sharing, open and FAIR research etc...

What is a CRP

Coordinated Research Project:

Representatives from 15-20 institutes worldwide
IAEA - sponsoring and coordinating body

Duration
    4–5 years (AI4Fusion is 5 years)
    Coordination Meetings (~every 6–12 months)
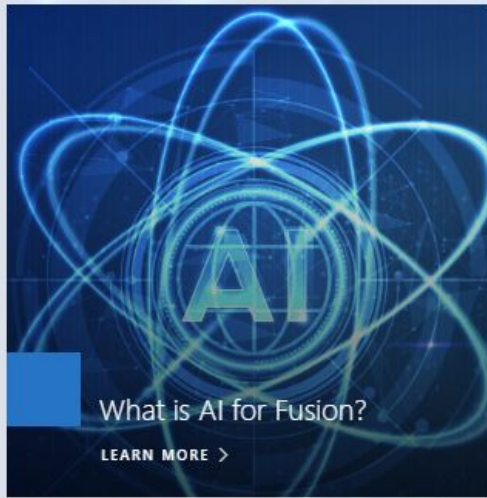   at IAEA's expenses

Financial Support
    Research, technical and doctoral contracts get financial
    support per annum per contract
    Research agreements are cost free agreements

Platform:
https://nucleus.iaea.org/sites/ai4atoms/ai4fusion

➢ **Nucleus account needed**

Roadmap
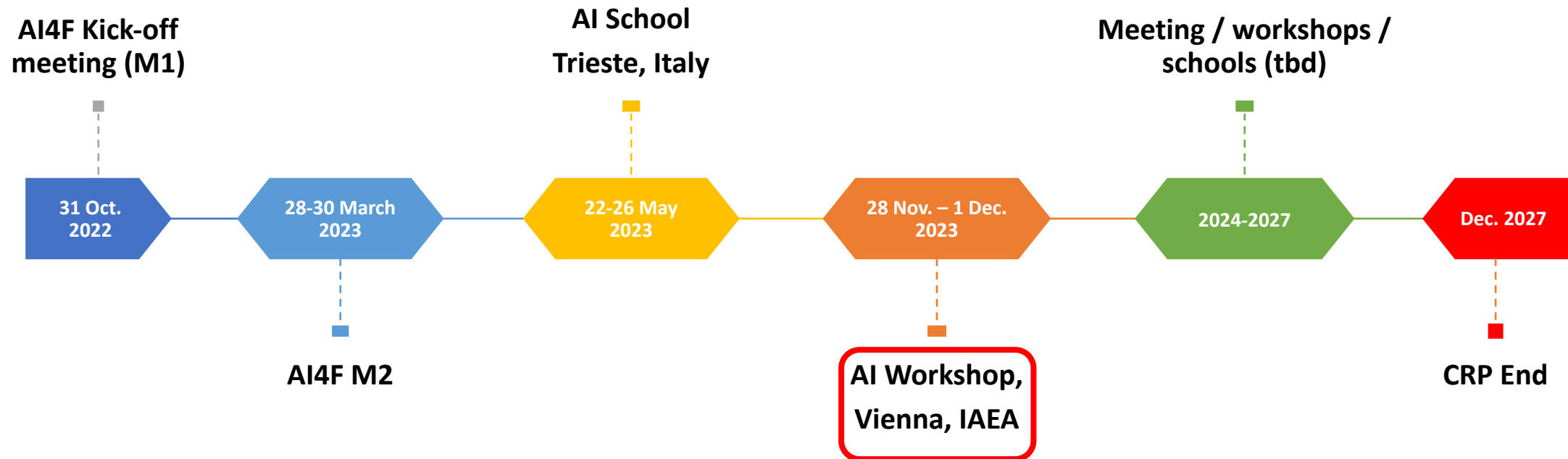
AI4F Working Structure (2022-2027)

Management and Coordination Team	⟷	NACA - Research Contracts Administration Section

AI4F participants

- **Australia (**The Australian National University)
- **China** (HUST, ASIPP, Shanghai Jiao Tong University, SWIP)
- **Germany** (IPP)
- **India** (IPR)
- **Italy** (ENI, University of Cagliari)
- **Japan** (NIFS, Osaka University)
- **Rep. of Korea** (KFE)
- **Sweden** (Chalmers)
- **Switzerland** (EPFL)
- **UK** (UKAEA, Imperial College London, First Light Fusion)
- **USA** (GA, MIT-PSFC, PPPL, University of Notre Dame, UW-Madison, W&M)

AI4F observers

- **ITER Organization**
- **International Telecommunication Union (ITU)**

OLA – Office of Legal

| WP1	WP2	WP3	WP4
MFE	IFE	MFE/IFE Image DB	Community

AI4Fusion CRP

Real-time MFE System Behaviour Prediction, Identification & Optimization Using ML/AI Methods

- To accelerate fusion R&D by establishing a multi-machine database of experimental and simulation MFE data (adhering to FAIR/Open Science principles) for ML/AI-driven applications, and through increased access to knowledge and information of ML/AI methods for MFE.
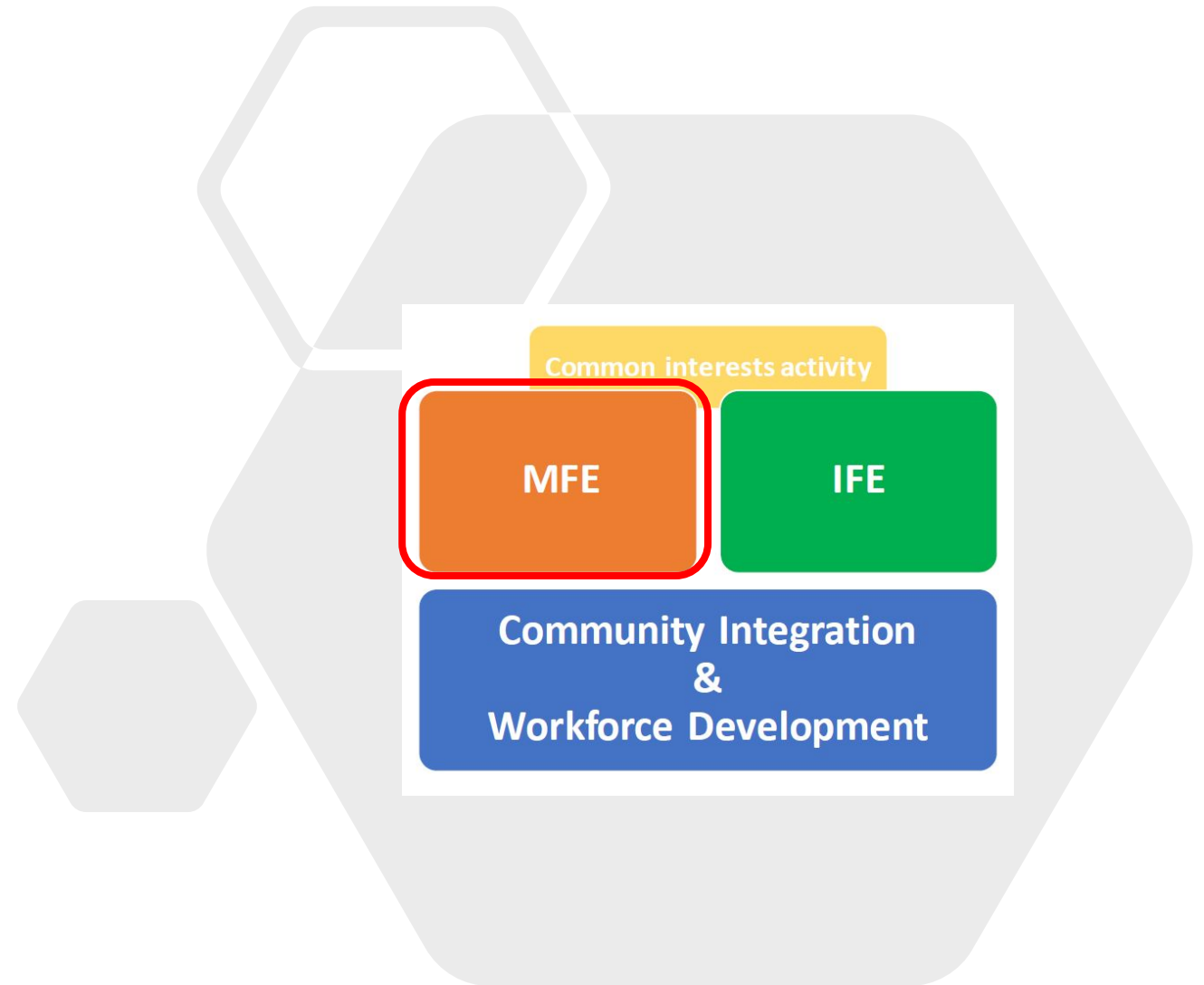
AI4Fusion CRP

**IFE Physics Understanding through Simulation, Theory and Experiment Using ML/AI Methods**

- To accelerate fusion R&D by establishing a database of experimental and simulation IFE data (adhering to FAIR/Open Science principles) for ML/AI-driven applications, and through increased access to knowledge and information of ML/AI methods for IFE.

Common interests activity

MFE   IFE

Community Integration & Workforce Development
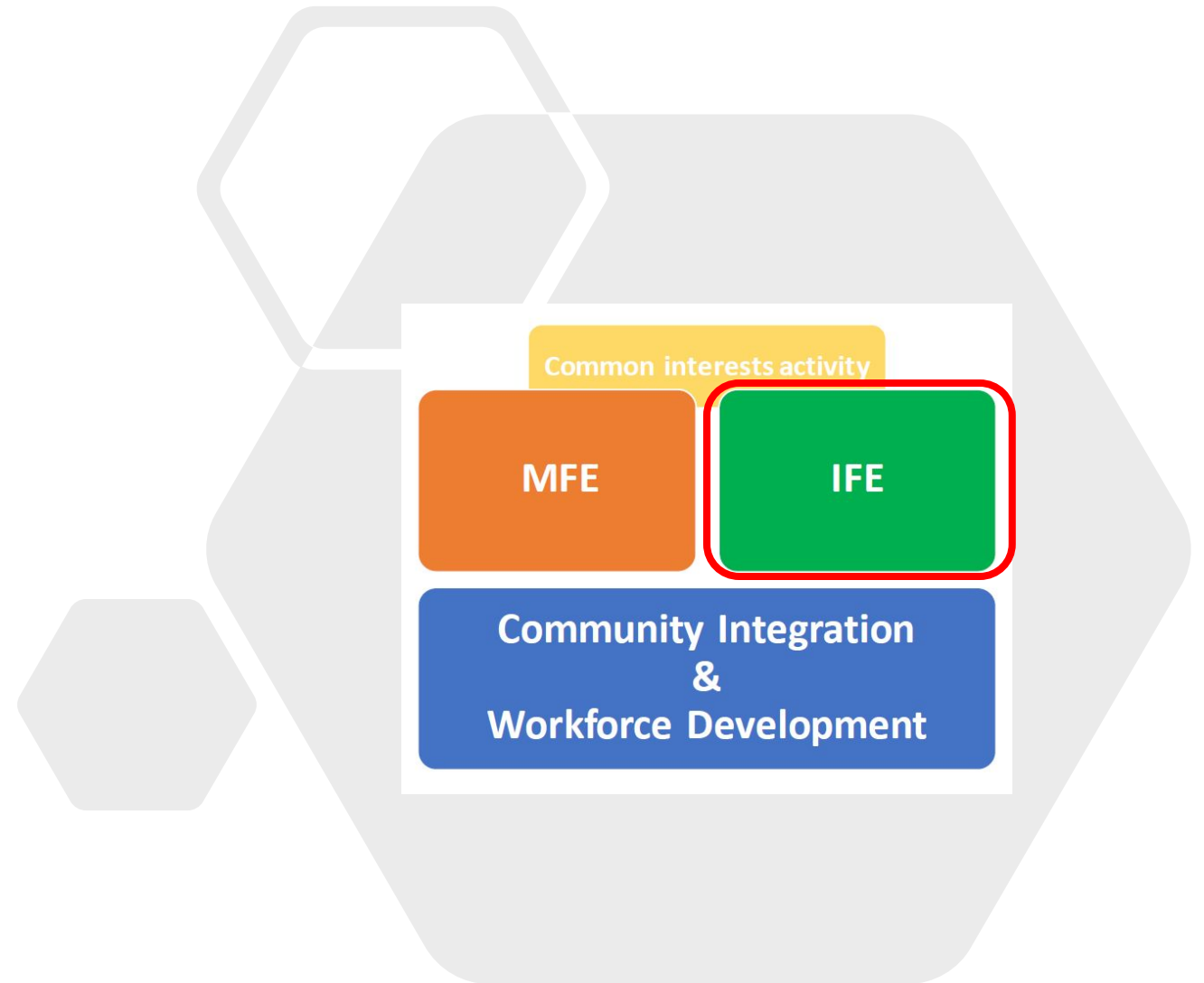
AI4Fusion CRP

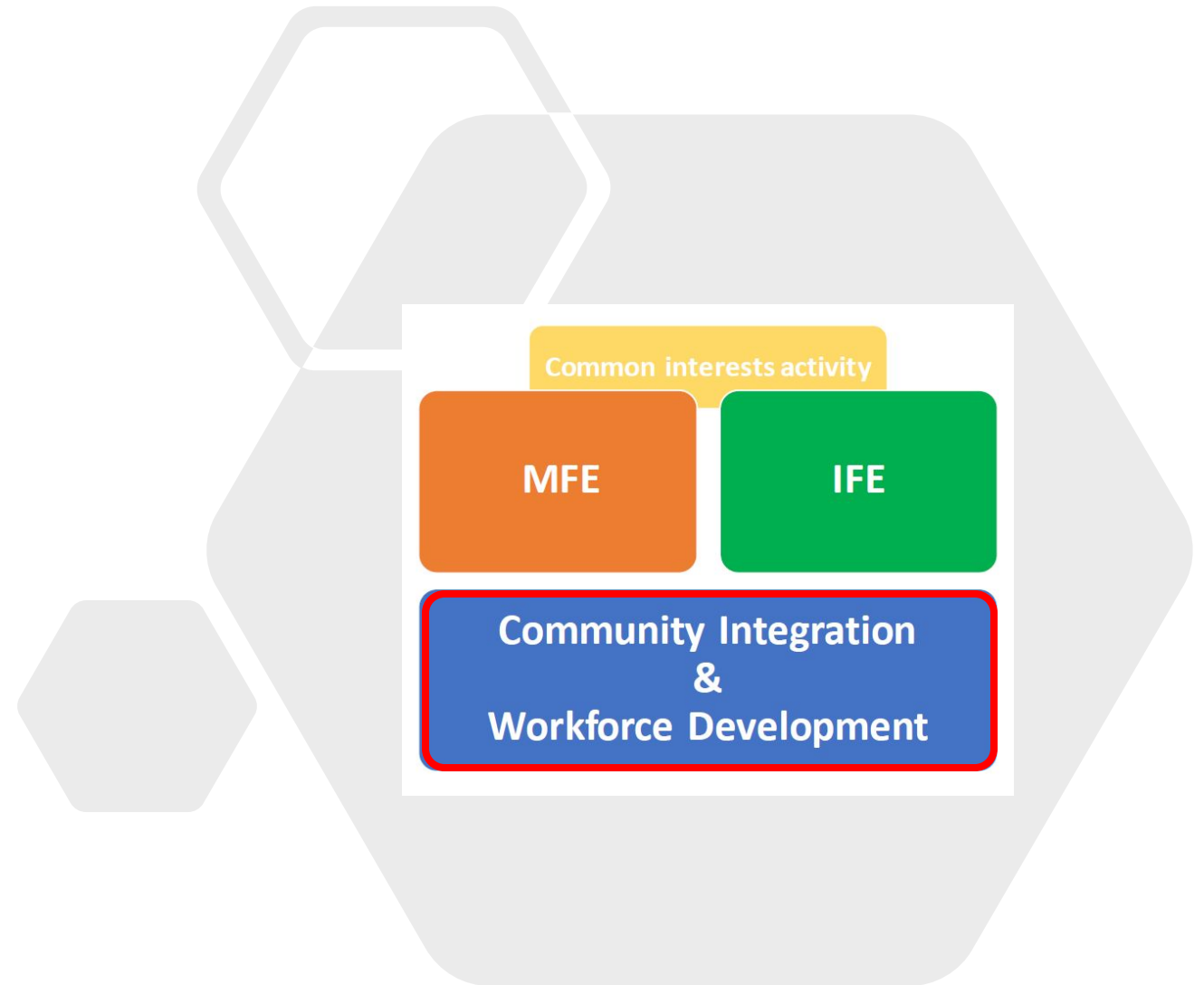**Feasibility of MFE and IFE Image Database**

- To determine the feasibility of an image database from MFE and IFE data (adhering to FAIR/Open Science principles) for ML/AI-driven applications with potential to accelerate fusion R&D.
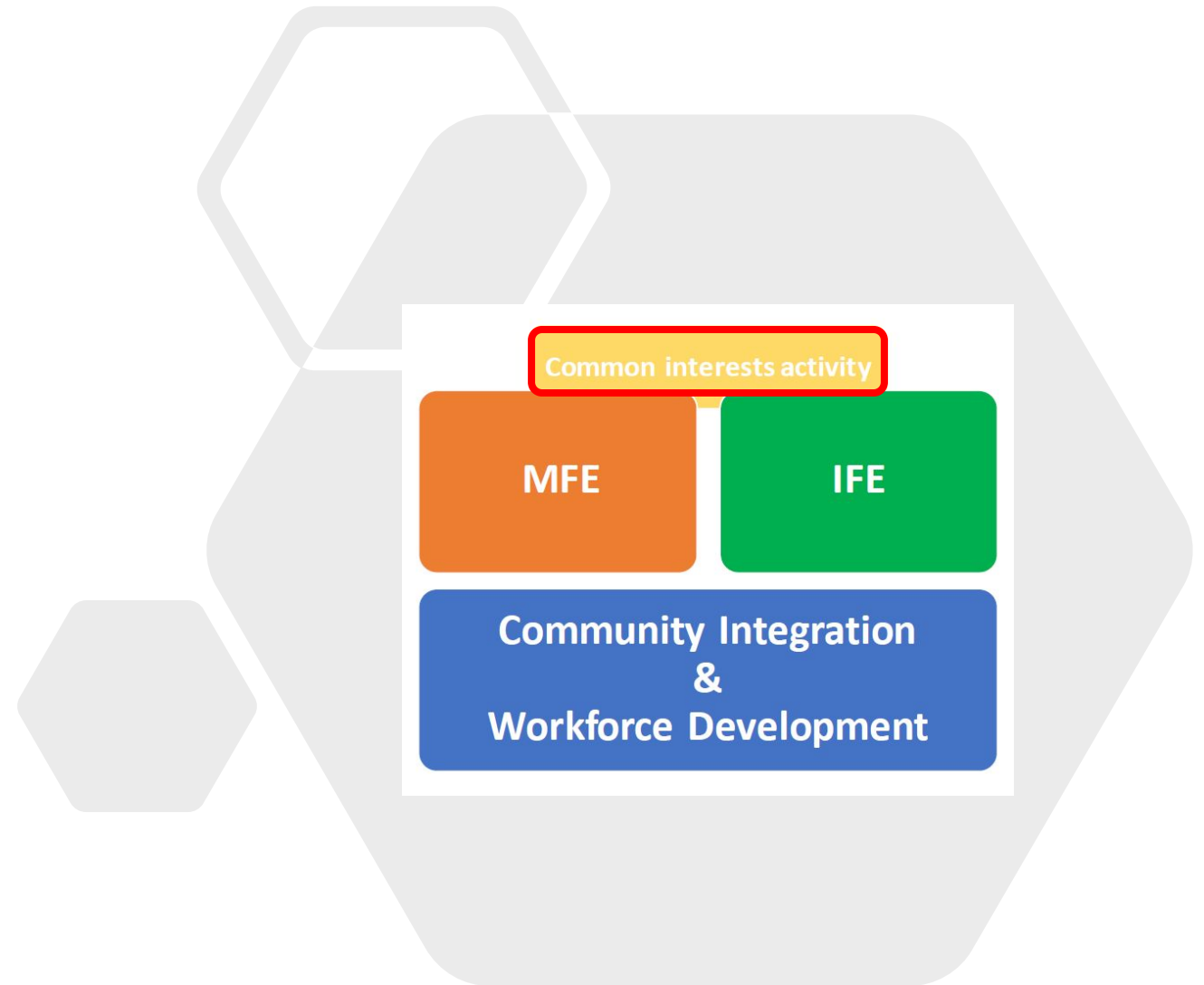
AI4Fusion CRP

Community Engagement and Workforce Development

- To accelerate community integration, engagement and capacity building, as well as create and provide with access to knowledge and information in the area of ML/AI methods applied to fusion R&D

- **AI for Fusion digital platform**.

AI4Fusion Use Cases

Work Package	Title	AI4F Proposers
WP3	Automatic detection of hot spots in the infrared images with NN	M. Jakubowski, IPP, Germany
WP1+WP4	An AI for Fusion challenge using C-Mod and J-TEXT data	Z. Wei, HUST, China; C. Rea, MIT, USA; T. Basikolo, ITU
WP2	An IFE simulation database and an application in Bayesian data assimilation	A. Crilly, Imperial College, UK; R. McClarren, University of Notre Dame, USA
WP1	Predicting the evolution of plasma parameters according to the present status and scheduled actuators actions based on AI techniques	Z. Yang, SWIP, China
WP1	1. Accurate and quick calculation of plasma position, equilibrium, instability growth (such as vertical growth) by machine learning. 2. The prediction of disruption caused by various reasons such as impurity, MARFEE, VDE and others by machine learning. 3. Discharge control by machine learning.	B. Xiao, ASIPP, China
WP1	A standardization framework for system simulation codes	D. Böckenhoff, IPP, Germany

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completed! (annotation on WP1+WP4 row)

AI4Fusion - ITU Data Challenge

- **MIT Plasma Science and Fusion Center (PSFC) + Huazhong University of Science and Technology (HUST) + Southwestern Institute of Physics (SWIP)** worked under the IAEA Coordinated Research Project on AI for Fusion to share data and workflows for the "**Multi-Machine Disruption Prediction Challenge for Fusion Energy**".

  - Data selected from **Alcator C-Mod, J-TEXT**, and **HL-2A**

- **ITU** has led the organization of a **data challenge** hosted by the Zindi platform:

https://zindi.africa/competitions/multi-machine-disruption-prediction-challenge

Finalists to be announced at upcoming webinar on Dec 12:

https://aiforgood.itu.int/event/ai-for-fusion-energy-challenge-finale-multi-machine-disruption-prediction/